INVESTIGATION OF MESH SENSITIVITY OF FDS RESULTS FOR AIR CURTAIN FLOWS

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Introduction

The present mesh sensitivity analysis is part of a numerical study of the effectiveness of air curtains in confining fire induced smoke. Figure 1 shows a sketch of the configuration. The width of the nozzle is 2cm while the length varies from 2cm to 40cm.

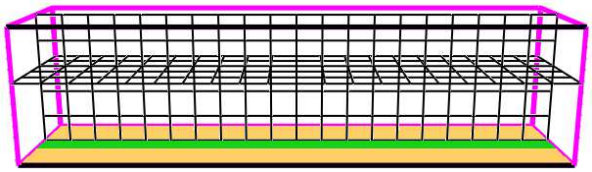

Fig. 1. Sketch of the nozzle and the computational domain. (Nozzle in green width=2cm, length=40cm, cell size=2cmx2cmx2cm)

In the present work, the Large Eddy Simulation (LES) turbulence model implemented by the Fire Dynamics Simulator (FDS), Version 6.0 [1], was used. In [2], it is stated that at least 10 cells must be applied within the characteristic diameter. For a rectangular nozzle, the hydraulic diameter, $D_h = 2LW/(L+W)$, can be used. A mesh sensitivity study is performed to assess the inlet boundary conditions.

Analysis of results

To investigate the influence of the L/W ratio (The ratio of length to width of rectangular nozzle) and cells number on velocity output value, a rectangular nozzle was adopted. The number of the cells across the nozzle width is varied from 1 to 10. The number of the cells across the nozzle length is varied from 1 to 200 accordingly.

Fig. 2 shows the velocity output/ input ratios for the different number of cells across the width for different rectangular nozzle dimensions, i.e. what velocity comes out of the nozzle, compared to what was meant to come out (i.e., to what was defined as input). Ideally, the ratio is 1.

It is observed that the velocity output/ input ratio increase significantly with the number of cells across the width of the rectangular nozzle for a given L/W ratio. E.g., for large enough L/W, there is an increase from 0.818 to 0.996 when the number of the cells across the nozzle width increases from 1 to 8 (and to 0.998 with 10 cells across the nozzle width).

Also, with 10 cells across the nozzle width, the ratio remains very close to 1, even for small L/W values. For fewer cells across the width, the ratio drops for lower L/W ratios (although the deviation remains as low as 3% for 5 cells across the width).

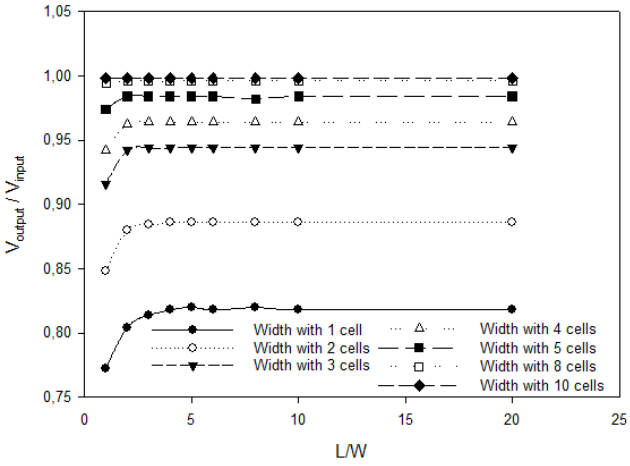

Fig.2 Velocity output/ input ratios for different nozzle dimensions and different numbers of cells across the width.

Conclusions

The number of cells across the width of the rectangular nozzle is a key parameter for accuracy of FDS results for air curtain flows. For deviations at the level of the inflow less than 5%, it is necessary to have at least 5 cells across the nozzle width, which agrees well with the criterion of 10 cells across the characteristic diameter (if defined as the hydraulic diameter). On the poster, flow field results are also discussed, in particular the velocity decay and entrainment phenomena.

Acknowledgement

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References

[1] McGrattan, K., et al. "Fire Dynamics Simulator, Technical Reference Guide, Volume 1: Mathematical Model." National Institute of Standards and Technology (2013).

[2] McGrattan K.B., Baum H.R., Rehm R.G., Large eddy simulations of smoke movement, Fire Safety J, 30: 161-78 (1998).

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